INTER-AMERICAN TROPICAL TUNA COMMISSION

REVIEW OF THE IATTC PROPOSED INTEGRATED PORT SAMPLING PROGRAM

1ST MEETING

La Jolla, California (USA)
3-5 November 2025

REVIEW OF THE PROPOSED IATTC INTEGRATED PORT SAMPLING PROGRAM

Reviewers: Simon D Hoyle and Xin Wang

SUMMARY

A hybrid review of the proposed IATTC Integrated Port Sampling Program was held at La Jolla 3 - 5 November 2025. The reviewers included Drs Simon D Hoyle and Xin Wang. Dr Wang attended in person and Dr Hoyle attended virtually.

The proposed integrated port sampling program (IPSP) is designed to minimize the need for subjective decision making and to ensure that sampling of large purse-seine vessels is representative. The analyses presented in the workshop materials and related documents provide reliable evidence of the potential for bias in existing sampling, and the need for improvements. IATTC staff propose to obtain systematic samples across the entirety of OBJ wells. We consider this to be a clear improvement over the nonrandom TPS approach, given the presence of layering. It is important to obtain data that improves understanding of the causes of layering, which may benefit future sampling and help develop methods to correct results from past data.

An important consideration is that sampling methods need to be based on how the data is used, both for estimation of catch and length frequency data, and in stock assessments. Data analysis methods are still under development, and there has not yet been much prioritization work using stock assessments.

Model-based estimation will be required to provide estimates for non-sampleable components of the catch. Model-based estimation is also likely to provide more precise estimates than design-based estimation of size and species composition for the sampled components of the catch. Given the need for model-based methods for some purposes, and their likely advantages for most purposes, it may be best to prioritize model-based methods and use design-based methods for validation for domains with large sample sizes. Resources for analysis and method development are limited, and it is better to focus on fewer approaches than to divide effort and attention across multiple estimation methods.

The proposed sampling methods appear to be generally suitable for providing data for the proposed analysis methods. However, data from the IPSP will provide future opportunities to improve efficiency and reallocate effort. Further simulation work will be needed to compare the efficiency and effectiveness of alternative sampling approaches.

Prioritization of resource allocation to sampling, simulation testing of sampling, and simulation testing of stock assessment depends on the objectives of the sampling program. It would be useful to explicitly identify any such higher-level objectives. These are needed to justify research prioritization.

1. INTRODUCTION

A hybrid review of the proposed IATTC Integrated Port Sampling Program was held at La Jolla 3 - 5 November 2025. The reviewers included Drs Simon D Hoyle and Xin Wang. Dr Wang attended in person and Dr Hoyle attended virtually. The IATTC Secretariat staff is in the process of merging the objectives of the Enhanced Monitoring Program (EMP) and the Traditional Port Sampling, as well as improving the sampling and catch estimation in general. The goal of the review was to elicit advice from outside

experts on the suitability of the proposed program (IPSP) and to get advice on possible improvements for 1) the sampling program and 2) the methods used to estimate the catch and its composition. The objectives included:

a) Review and evaluate the appropriateness of the proposed sampling design

b) Provide advice on improving the sampling design for implementation in January 2026

c) Identify future research to improve the sampling design

d) Provide advice on catch estimation methods

The terms of reference are provided in Appendix I. The agenda is provided in Appendix 2. Appendix 3 provides a list of participants. Note that there were no analysis requests or public comments.

2. JUSTIFICATION FOR CHANGING THE SAMPLING DESIGN

The IATTC staff have identified issues with the current (TPS) sampling design that are likely to affect the resulting estimates of species and size composition. For example, the TPS analysis approach assumes that fish are sampled from wells using simple random sampling (SRS), and that wells are sampled randomly with respect to differences in fishing strategies among vessels. However, in practice, opportunistic sampling occurs, which will lead to unbalanced sampling if there is spatial and temporal structure in availability, fishing strategy, and/or species and size composition. Analysis of the sampled data showed evidence of considerable spatial and/or temporal structure in fishing strategies, species and size composition, and the proportions of trips and proportions of wells sampled. For example, samples were obtained from a higher proportion of trips offloading in Mexican ports versus Ecuadorian ports, and with more wells per trip sampled from Mexican ports.

In addition, the EMP pilot study (SAC-14-10), which sampled every tenth container in OBJ fishing wells, identified substantial large-scale within-well patterns in species composition during unloading (referred to here as 'layering'), characterized by autocorrelation and trends in the proportion of each species across the sequence of containers unloaded. In the wells sampled in the EMP pilot study, there were substantial and variable trends in the proportion of bigeye per container during the process of unloading. Although there was variability between wells, there was also, on average, a higher proportion of bigeye in the first half of the well. These factors are significant because the opportunistic nature of TPS led to 76% of samples coming from the upper half of the well and 6% from the bottom quarter, which would tend to bias estimates towards the proportion in the first half of the well. They would also lead to a high level of within-well variance in the estimate of species composition.

We note that understanding the processes that lead to layering should help to improve sampling design. This understanding can also help analysts to estimate the potential for bias in past sampling. Understanding biases may allow analysts to identify ways to adjust for them.

Adjusting for past biases is likely to benefit stock assessment, since it may substantially lengthen the time series of comparable data.

Causes of layering have been shown to include the order in which sets are added to wells. Other processes may also affect the degree and pattern of layering, such as sorting effects during brailing, loading, and offloading; and mixing, percolation, and flotation within the well. The relative contributions to layering of different processes are currently unknown. They may vary according to the brailing, loading, storage, and offloading methods used by the vessel.

Layering of species composition in DEL and NOA wells has not yet been quantified but is also likely. The same applies to layering by size composition in all well types. We support the proposal for additional analyses to document layering by size and species composition in wells of all set types.

In summary, the analyses presented in the workshop materials and related documents provide reliable evidence of the potential for bias in existing sampling, and the need for improvements. These issues have been well documented in reports to the SAC and in peer-reviewed publications, with peer review

providing additional confidence in their conclusions. These documents and analyses provide a sound foundation for the development of improved sampling methods.

3. PROPOSED SAMPLING DESIGN

The proposed integrated port sampling program (IPSP) is designed to minimize the need for subjective decision making and to ensure that sampling of large purse-seine vessels is representative.

An important issue is that some components of the catch will not be sampled.

- Sampling focuses on wells that include fish from a single set type. Mixed wells will not be sampled.
- Sampling will occur in 4 ports (Manta and Posorja in Ecuador, and Mazatlán and Manzanillo in Mexico), but some trips offload in other ports where there is no sampling.
- Vessels that offload using cargo nets will not be sampled.
- Only large purse seine vessels (class 6) will be sampled.

One constraint in assessing the proposed sampling design is that the optimal design for sampling depends on the methods that will be used to analyze the data, and these analysis methods are still under development. The provided review materials describe a simple design-based estimator for fleet-level species composition, and they also discuss model-based approaches.

We suggest that analysis methods may include a component of design-based estimation, but we believe that there will also be a requirement for model-based estimation.

Model-based estimation will be required to provide estimates for non-sampleable components of the catch. This is because the species and size composition of non-sampleable sets and trips are likely to differ in systematic ways from the sampled sets and trips. As a result, estimating their catch will require model-based methods.

Model-based estimation is also likely to provide more precise estimates than design-based estimation of size and species composition for the sampled components of the catch. This greater precision may allow future sampling to be undertaken more efficiently via reallocation of resources. As mentioned above, it may also allow future analysts to recalculate the results from TPS sampling, which could be important for the long time-series of size and catch data used in stock assessment.

Model-based methods may also be more helpful than design-based estimation for developing estimates of catch and size composition for alternative stock assessment fishery structures, by avoiding post-stratification sparsity problems when domain boundaries change.

Model-based estimation methods will be required to develop estimates of size composition at the population level for index fisheries (i.e., YFT dolphin fisheries)(Maunder et al., 2020).

Nevertheless, design-based methods do have some advantages over model-based methods. Their estimates do not rely on assumptions about the characteristics and distribution of the catch data, and they are therefore more robust to these issues if sample sizes are sufficiently large. They are also computationally simpler and more transparent to non-experts than model-based methods.

Given the need for model-based methods for some purposes, and their likely advantages for most purposes, it may be best to prioritize model-based methods and use design-based methods for validation for domains with large sample sizes. Resources for analysis and method development are limited, and it is better to focus on fewer approaches than to divide effort and attention across multiple estimation methods.

3.1. Well-level sampling

IATTC staff propose to obtain systematic samples across the entirety of OBJ wells. We consider this to be a clear improvement over the nonrandom TPS approach, given the presence of layering. They report

that simulation results suggest lower variance estimates for systematic than for SRS sampling, and they note that systematic sampling is likely to be easier to manage logistically and therefore more efficient.

Systematic sampling has a further advantage that it should better characterize layering by species and size. It is important to obtain data that improves understanding of the causes of layering, which may benefit future sampling and help develop methods to correct results from past data.

We support recommendations for future simulation work once more data has been collected. Simulation can be used to identify more efficient allocation of sampling.

3.2. Cluster sampling

IATTC staff propose cluster sampling of trips. We agree that this is an effective way to achieve representative coverage of trips across seasons and the sampled ports. It gives each sampleable trip the same probability of being sampled, whereas the TPS approach meant that sampling probabilities were lower during periods with more trips.

We note that if a trip cannot be sampled for some reason, replacing it with another trip would be helpful if missing trips can be represented by other trips, but is not essential. Sampling weights can be adjusted to reflect the missing trips. In model-based approaches, auxiliary information can also be used to predict missing trips.

If using a design-based approach, sampling weights can be adjusted to allow for missing strata/cells. Model-based catch estimation is also (probably more so) robust.

IATTC staff recommend well selection using simple random sampling, taking 3 wells per trip. We agree that this is an improvement on the TPS approach of 1-3 wells per trip, because it will help to estimate the level of within-trip variation.

IATTC staff raised the issue of variation in volume among wells. This may affect sampling, in the sense that sampling of smaller wells will result in more variance in species composition. The observed variance can be high when the number of observations per well is low. Smaller wells provide fewer containers, and there may need to be lower threshold for the number of containers from a well to manage the level of within-well variance. This may be explored using simulation once enough data has been obtained. The sampling variances or sample sizes at well level should be considered in model-based approaches for modeling well level estimates.

Another possible concern is that skippers may choose to use wells of different sizes in different ways, leading to species composition or size composition patterns associated with well size. If so, this can be adjusted for using model-based estimation methods. However, estimates from design-based methods may be affected if they treat well sizes as equivalent. If the effect size is large, sampling should be balanced across well sizes.

We also note that small wells are more likely to include catch from a single set, and cells with a single set may provide better information for design-based modeling.

For design-based estimation, should the sample weights allow for well size? Under the current approach, sampling weights adjust only for the probability that a well is selected. Well size is allowed for in the y parameter, i.e., the number of fish sampled. Well size can be accounted for by making selection probability proportional to the well size. This requires well size to be known before sampling. Making sampling probability proportional to well size will reduce the variance of design-based estimates.

For model-based estimation, sampling variance at the well level should be considered. Model-based estimates apply at the well level rather than at the fish level. The well-level estimates are calculated based on sampling weights.

The probability of sampling 2 or more wells that contain the same set is not a concern, because it should match the pattern in the well population, and will not affect representativeness.

It should be possible to adapt the sampling in the future to increase coverage of under-represented set types (e.g., NOA), if needed. It is possible to adjust sampling weights case-by-case based on how much sampling has been undertaken.

3.3. Future research to improve sampling design

The first point to make here is that sampling methods need to be based on how the data is used, both for estimation of catch and length frequency data, and in stock assessments. If sampling improvements significantly affect the stock assessments data inputs, they can also affect stock assessment advice. Data analysis methods are still under development, and there has not yet been much prioritization work using stock assessments.

The proposed sampling methods appear to be generally suitable for providing data for the proposed analysis methods. However, data from the IPSP will provide future opportunities to improve efficiency and reallocate effort. Further simulation work will be needed to compare the efficiency and effectiveness of alternative sampling approaches.

One important issue is the uncertainty about the prevalence and characteristics of layering of species composition across NOA and DEL wells, and of size composition across all well types. Some data on NOA and DEL wells are available from 113 wells sampled in 2024 during Project C.1.b. Analyses of these data are planned for late 2025. The result of these analyses may or may not support the need for systematic sampling across the whole rather than ¼ of each NOA or DEL well. Alternatively, more information may be needed, in which case it may be useful to consider a small proportion of systematic sampling across NOA and DEL wells during IPSP sampling.

Simulation and analysis work should consider potential biasing factors such as relationships between set weight and species composition and/or size composition. These effects are important for model-based estimation, which will be required for mixed wells, and average set sizes may vary between mixed and unmixed wells.

4. PRIORITIZATION

Prioritization of resource allocation to sampling, simulation testing of sampling, and simulation testing of stock assessment depends on the objectives of the sampling program. The materials provided to reviewers include sections on the assumptions and purpose of the ISPS sampling protocol, but these sections focus on practical objectives such as estimating annual fleet-level species catch for the fisheries defined in the tuna stock assessments and generating data for design-based estimation. We assume that the higher-level objective is to optimize the stock assessment outcomes, but this objective is not identified in the material provided. It would be useful to explicitly identify any such higher-level objectives. These are needed to justify research prioritization.

In our view, research is needed to determine which issues have more impact on stock assessment outcomes, such as how to allocate resources between size composition from DEL vs OBJ sets vs species composition data from OBJ sets. Analysts will need to consider how much precision is needed, and how much bias is permissible.

A related point is that representative size composition data can (in our experience) be more important for stock assessment outcomes than species composition data. Stock assessment outcomes are largely determined by population trend (mainly driven by CPUE) and population scale (substantially affected by size data). Species composition data changes may primarily affect catch estimates, particularly for bigeye. Adjustments to total catch estimates, especially of small fish, can often be absorbed by changes in recruitment estimates and have relatively little impact on stock status estimates.

However, these impacts are case-specific and depend on how stock assessments are configured, and how input data are prepared. Size composition data changes may affect selectivity estimates for all species, and the effects of size composition transitions will depend on whether selectivities are assumed to be time-varying, and the likelihood weights given to size data. Work is needed with stock

assessments to identify which data components (and sampling programs) are more influential and in what circumstances. Assessment analysts will need to consider how future assessments will deal with transitions between sampling methods / changes in data quality in both catch estimates and size comp data. Sampling may also need to address administrative requirements such as the need to compare estimated catches with catch thresholds.

5. CATCH ESTIMATION PROCESS

The documentation described options for catch estimation. This process can be carried out using design-based or model-based methods. Although model-based methods may be prioritized, here we review proposals for both approaches.

5.1. Sampling weights

Sets in a sampled well may come from more than one domain. For design-based estimation, the sampling weights should be adjusted to allow for the proportions of the fish in wells that come from the domain of interest. The sampling weights should be adjusted based on the total catch of domains.

5.2. Integrated approach

The integrated method approach proposed is relatively undeveloped, but it looks promising. We agree that this approach should make the best use of the available data, and that it is flexible. We think that this method should be computationally feasible at least at some level. We support the analysts' proposal to begin with simple integrated approaches and progressively add complexity. Methods development can use TPS data so does not need to wait for IPSP data collection.

We agree that it will initially be best to run integrated models independently by set type. Combining set types would add considerable complexity, because each set type catches different fish sizes and species mixes, and fish sizes and species compositions vary spatially. Spatiotemporal patterns will therefore differ between set types, which means that few parameters can be shared between set types.

During the meeting there was discussion of trying to allocate parts of each well-level sample at the set level by determining break points within each well (or other methods). However, this may not be feasible. It may be better to aggregate the set-by-set predictions from the 'real' model to the well level and compare these aggregate predictions with the observed sampling data.

Sample weighting for model-based methods is different from design-based methods. It occurs in 2 stages: during estimation and prediction. During estimation, sample weighting is based on the amount of information in the data, i.e., the effective sample sizes of individual observations. Upweighting to the represented stratum occurs during the prediction phase, when species composition is predicted for each set in the stratum.

6. LENGTH COMPOSITION ESTIMATION PROCESS

The comments earlier about design versus model-based methods for catch estimation also apply to estimation of size composition.

We note that model-based methods will be needed to predict size composition at the population level, e.g., for DEL YFT index fisheries.

For examples of model-based analysis of size composition data, see analyses for New Zealand albacore tuna (Neubauer & Hill-Moana, 2024), for rock lobster (Webber, 2022), and methods for estimating age composition from length data (Webber et al., 2024).

7. REFERENCES

Maunder, M. N., Thorson, J. T., Xu, H., Oliveros-Ramos, R., Hoyle, S. D., Tremblay-Boyer, L., Lee, H. H., Kai, M., Chang, S.-K., & Kitakado, T. (2020). The need for spatio-temporal modeling to determine catch-per-unit effort based indices of abundance and associated composition data for inclusion in stock assessment models. *Fisheries Research*, *229*, 105594. https://doi.org/10.1016/j.fishres.2020.105594

Neubauer, P., & Hill-Moana, T. (2024, 14 – 21 August 2024). *Characterisation, CPUE and length-composition analyses of the New Zealand albacore fishery. WCPFC-SC20-2024/SA-IP-18* WCPFC Scientific Committee 20, Manila, Philippines.

Webber, D. (2022). Modelling the length frequency of red rock lobsters (*Jasus edwardsii*) in New Zealand. *New Zealand Fisheries Assessment Report*, *2022/30*, 261. https://fs.fish.govt.nz/Doc/25275/FAR-2022-30-Modelling-Length-Frequency-Of-New-Zealand-Red-Rock-Lobster-4292.pdf.ashx

Webber, D., Dunn, A., & Mormede, S. (2024). Development of models for estimating age and length compositions from length and age observations. *New Zealand Fisheries Assessment Report*, *2024/29*, 79. https://fs.fish.govt.nz/Doc/25747/FAR-2024-29-Models-for-estimating-age-and-length-compositions.pdf.ashx

Appendix 1: Terms of Reference

1) Read the background document: RVSPL-01 “Proposed IPSP probability sampling protocol for collection of purse-seine port-sampling data”

2) Attend the review meeting in person where possible or virtually

3) Review and evaluate the appropriateness of the proposed sampling design

4) Provide advice on improving the sampling design for implementation in January 2026

5) Identify future research to improve the sampling design

6) Provide advice on catch estimation methods

7) Write a report describing the review panel’s conclusions

Appendix 2: Agenda

Monday Nov 3

11:00 Introduction and welcome

11:10 Presentation: proposed IPSP sampling protocol

12:10 Discussion

1:10 Report writing

1:40 Homework assignments

1:50 Public comment

Tuesday Nov 4

11:00 Homework review

11:10 Presentation: Catch estimation approaches

12:10 Discussion

1:10 Report writing

1:40 Homework assignments

1:50 Public comment

Wednesday Nov 5

11:00 Homework review

11:10 Discussion

11:40 Report writing

1:10 Panel presentation

1:40 Public comment

1:50 Closing remarks

Appendix 3: Participants

Reviewers

Simon D Hoyle, Consultant, Nelson, New Zealand.

Xin Wang, Assistant Professor Xin Wang of the Department of Mathematics and Statistics at San Diego State University, Sab Diego, CA, USA.

Secretariat staff

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Other participants

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Report format

The Panel's report should be drafted and approved shortly after the meeting. The report writing process will follow these steps:

a. Panel outlines report at the meeting;
b. Panel writes and agrees on the draft report;
c. Panel provides draft report to IATTC staff for comment on technical accuracy; and
d. Panel reviews staff comments, and modifies report as necessary.

The report will include:

a. names and affiliations of Panel members;
b. brief overview of the meeting (location, agenda, main recommendations by Panel, *etc.*);
c. brief summary of current data used in the assessment and associated analyses;
d. list of analyses requested by the Panel, rationale for each request, and brief summary of the responses;
e. comments on technical merits and/or deficiencies in the data used in the assessments and associated analyses, and recommendations for remedies;
f. unresolved problems and major uncertainties, *e.g.*, any special issues that complicate the use of the data or the analyses conducted;
g. data, fishery or analysis related issues raised by the public; and
h. prioritized recommendations for research and data collection for the subsequent assessments.

The Panel and the IATTC staff will strive to resolve any differences of opinion that may arise regarding the contents of the report. Any unresolved differences of opinion must be documented and reflected in the report, which will be published as an IATTC Special Report.